

**What is claimed is:**

1           1. A direct frequency synthesizer, comprising:  
2           a first frequency division path dividing an applied reference signal by a first divisor to  
3           provide a first signal;  
4           a second frequency division path dividing the reference signal by a second divisor to  
5           provide a second signal and dividing the second signal by a third divisor to provide a third signal,  
6           the second frequency division path having a mixer receiving the second signal and the third  
7           signal; and  
8           an output mixer receiving the first signal and a product of the second signal and the third  
9           signal, and providing an output signal having a frequency relationship to the applied reference  
10          signal.

1           2. The direct frequency synthesizer of claim 1 wherein the output signal has a frequency  
2           of a designated mixing product of the second signal and the third signal, offset in frequency by  
3           the frequency of the first signal.

1           3. The direct frequency synthesizer of claim 1 further comprising an offset loop  
2           synthesizer receiving the output signal.

1           4. The direct frequency synthesizer of claim 2 further comprising an offset loop  
2           synthesizer receiving the output signal.

1           5. The direct frequency synthesizer of claim 3 wherein the offset loop synthesizer  
2 provides a first local oscillator signal for a spectrum analyzer.

1           6. The direct frequency synthesizer of claim 5 wherein the first local oscillator signal has  
2 a frequency equal to a harmonic multiple of the frequency of the output signal, offset in  
3 frequency by an interpolation signal in the offset loop synthesizer.

1           7. The direct frequency synthesizer of claim 5 wherein the reference signal is provided  
2 by a second local oscillator of the spectrum analyzer.

1           8. The direct frequency synthesizer of claim 1 wherein the first frequency division path  
2 includes a programmable frequency divider and fixed frequency divider cascaded with the  
3 programmable frequency divider providing the first signal.

1           9. The direct frequency synthesizer of claim 1 wherein the second frequency division  
2 path includes a first frequency divider having a fixed divisor and providing the second signal, and  
3 a second frequency divider having alternative divisor settings and providing the third signal.

1           10. The direct frequency synthesizer of claim 8 wherein the second frequency division  
2 path includes a first frequency divider having a fixed divisor and providing the second signal, and  
3 a second frequency divider having alternative divisor settings and providing the third signal.

1           11. The direct frequency synthesizer of claim 1 further comprising a filter selecting the  
2           output signal from a series of mixing products provided by the output mixer.

1           12. The direct frequency synthesizer of claim 5 wherein the offset loop synthesizer  
2           includes a harmonic mixer receiving the output signal and the first local oscillator signal and  
3           providing a mixing product to a frequency/phase detector that compares the mixing product with  
4           an interpolation signal to control a tuneable oscillator that provides the first local oscillator  
5           signal.

1           13. A direct frequency synthesizer, comprising:  
2           a first frequency division path dividing an applied reference signal by a first divisor to  
3           provide a first signal;  
4           a second frequency division path dividing the reference signal by a second divisor to  
5           provide a second signal and further dividing the second divided signal by a third divisor to  
6           provide a third signal, the second frequency division path having a mixer receiving the second  
7           signal and the third signal;  
8           an output mixer receiving the first signal and a product of the second signal and the third  
9           signal, providing a first output signal having a frequency relationship to the applied reference  
10          signal; and  
11          an offset loop synthesizer receiving the first output signal and providing a second output  
12          signal related in frequency to the first output signal and an interpolation signal within the offset  
13          loop synthesizer.

1           14. The direct frequency synthesizer of claim 13 wherein the reference signal is provided  
2           by a second local oscillator of a spectrum analyzer and the second output signal provides a first  
3           local oscillator signal in the spectrum analyzer.

1           15. The direct frequency synthesizer of claim 13 wherein the second output signal is a  
2           harmonic multiple of the first output signal offset by the interpolation signal.

1           16. The direct frequency synthesizer of claim 15 wherein the first output signal has a  
2           frequency of a designated mixing product of the second signal and the third signal, offset in  
3           frequency by the frequency of the first signal.

1           17. A direct frequency synthesis method, comprising:  
2           dividing an applied reference signal by a first divisor to provide a first signal;  
3           dividing the reference signal by a second divisor to provide a second signal;  
4           dividing the second signal by a third divisor to provide a third signal;  
5           mixing the second signal and the third signal; and  
6           mixing a designated product of the second signal and the third signal with the first signal  
7           to provide an output signal related in frequency to the applied reference signal.

1           18. The direct frequency synthesis method of claim 17 further comprising applying the  
2           output signal to an offset loop synthesizer.

1           19. The direct frequency synthesis method of claim 18 wherein the offset loop  
2 synthesizer provides a first local oscillator signal for a spectrum analyzer.

1           20. The direct frequency synthesis method of claim 19 wherein the reference signal is  
2 provided by a second local oscillator signal of the spectrum analyzer.